

DISTRIBUTION AND REGENERATION OF *HOLOPTELEA INTEGRIFOLIA* PLANCH. IN ALWAR DISTRICT, RAJASTHAN¹

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(With three text-figures)

Key words: Age structure, grazing, natural regeneration, samara, seedling population

Studies indicate that the distribution of *Holoptelea integrifolia* (Family: Ulmaceae) is restricted to hilly areas and reserve forests of Alwar district, Rajasthan. Although this species produces an enormous number of fruits (samara) per unit area, only a fraction of them form seedlings. Dry spells and high temperature in the monsoon, low temperature and soil moisture content in winter, dry and hot summer, and grazing adversely affect seedling survival. Observations from the four study sites (Dhobighatta hills, Sagar hills, Garvaji, R.R. College campus) in Alwar district, Rajasthan indicate that natural regeneration of *H. integrifolia* is taking place only in areas which are partially or fully protected against biotic disturbances.

INTRODUCTION

Holoptelea integrifolia grows in northeast Rajasthan and is reported to be the tallest tree in the region (Sharma and Tiagi, 1979). Unfortunately, despite being a fast growing, local tree species, it has not found use in afforestation. The extensive felling and lopping of *H. integrifolia* trees for timber and firewood has reduced its distribution in Alwar district, Rajasthan. It is, therefore, imperative to analyse the factors that are responsible for the poor regeneration of *H. integrifolia*.

STUDY AREA

Four sites were selected to study the natural regeneration of *Holoptelea integrifolia*. Two of these sites were located in hilly areas. The first site was an east facing slope at Dhobighatta hills, 6 km from Raj Rishi (R.R.) College, a highly disturbed area subjected to tree felling, and grazing by cows and goats. *Wrightia tinctoria*

and *Butea monosperma* (Table 1) dominated the plant community. *H. integrifolia* grew from the base to the middle of the hill slope. Most of them were young and produced as a result of coppicing of the felled trees. The soil was shallow, sandy loam mixed with gravel and small stones (Table 2). The second site was a northeast-facing slope at Sagar hills, about 5 km from R.R. College. It was declared a reserve forest by the Govt. of Rajasthan in 1984. Since then, it is fully protected with no major biotic disturbance. It is dominated by *Wrightia tinctoria* and *Anogeissus pendula* bushes (Table 1). *H. integrifolia* grew from the base to the middle of the hill slope. The soil type is similar to that of Dhobighatta hills (Table 2).

The other two sites were situated in plain areas, the first was the campus of R.R. College, surrounded by a high wall from all sides. The college campus was an orchard previously surrounding the palace of the Maharaja of Alwar, which was later rented to the Govt. of Rajasthan to house the R. R. College. The orchard was abandoned for 50 years, and is now converted into a forest dominated by *H. integrifolia* (Table 1). It is partially disturbed as about 10 buffaloes, 6 cows and 50 goats are allowed to

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TABLE 1
DENSITY AND FREQUENCY (%) OF HOLOPTELEA INTEGRIFOLIA AND ITS ASSOCIATED SHRUBS AND TREES AT THE FOUR STUDY SITES ($\pm$ S.E.)

Plant species	Dhobighatta hills			Sagar hills			R.R. College			Garvaji		
	Density	Frequency		Density	Frequency		Density	Frequency		Density	Frequency	
<i>Abutilon indicum</i>	-	-	-	-	-	-	4.5 $\pm$ 2.8	20	-	-	-	-
<i>Acacia leucophloea</i>	0.7 $\pm$ 0.3	40	-	-	-	-	-	-	-	0.9 $\pm$ 0.2	70	-
<i>Adhatoda vasica</i>	18 $\pm$ 2.2	100	-	44 $\pm$ 11.9	100	-	8.2 $\pm$ 5.2	30	-	53 $\pm$ 12	100	-
<i>Anogeissus pendula</i>	5 $\pm$ 1.7	60	-	10 $\pm$ 1.9	80	-	-	-	-	2.7 $\pm$ 0.5	100	-
<i>Butea monosperma</i>	2 $\pm$ 0.6	70	-	0.4 $\pm$ 0.3	10	-	-	-	-	-	-	-
<i>Capparis septaria</i>	4 $\pm$ 0.4	100	-	-	-	-	5.6 $\pm$ 1.8	70	-	-	-	-
<i>Cassia fistula</i>	0.1 $\pm$ 0.09	10	-	-	-	-	0.4 $\pm$ 0.2	30	-	-	-	-
<i>Cordia dichotoma</i>	-	-	-	-	-	-	0.3 $\pm$ 0.1	30	-	-	-	-
<i>Grewia flavescens</i>	-	-	-	0.7 $\pm$ 0.2	50	-	-	-	-	-	-	-
<i>Hibiscus micranthus</i>	1.2 $\pm$ 0.2	80	-	2.4 $\pm$ 0.7	60	-	-	-	-	-	-	-
<i>Holoptelea integrifolia</i>	3.1 $\pm$ 0.4	70	-	17.3 $\pm$ 1.3	100	-	11.4 $\pm$ 1.3	100	-	1.4 $\pm$ 0.1	60	-
<i>Lantana camara</i>	-	-	-	-	-	-	24.3 $\pm$ 3.1	100	-	-	-	-
<i>Prosopis juliflora</i>	-	-	-	-	-	-	1.9 $\pm$ 0.7	50	-	-	-	-
<i>Wrightia tinctoria</i>	14 $\pm$ 2.3	90	-	13 $\pm$ 1.7	100	-	-	-	-	-	-	-
<i>Ziziphus nummularia</i>	-	-	-	-	-	-	18.4 $\pm$ 9.2	50	-	2.8 $\pm$ 3.7	20	-

TABLE 2
PHYSICO-CHEMICAL CHARACTERISTICS OF THE FOUR STUDY SITES

Site	pH	E.C.	Organic Carbon (%)	Phosphorus kg/ha	Potassium kg/ha
Dhobighatta hills	7.8	0.38	0.45	63	240
Sagar hills	8.0	0.50	0.13	54	260
R.R. College campus	7.8	0.30	0.40	72	High
Garvaji	7.9	0.30	0.42	18	High

graze and trees are felled for timber and firewood. The soil is deep, well developed sandy loam (Table 2). The second site was located at the base of the hills near the Garvaji temple, 14 km from Alwar city. *Adhatoda vasica* dominated the plant community here (Table 1). The site is highly disturbed by tree felling and heavy cattle and goat grazing.

MATERIAL AND METHODS

The distribution of *Holoptelea integrifolia* in Alwar district was studied by visiting important locations in all the subdivisions and consulting the forest range officers of Alwar district. Its natural regeneration was studied in the four selected study sites in different locations. The density and frequency of *H. integrifolia* and its associated shrubs and trees was estimated at all four sites by laying 15 quadrats of 10 m x 10 m each. The circumference of the plants was measured at a height of 1 m for trees and just above the ground for seedlings and saplings.

From a known cohort of one year old plants, it was observed that the maximum circumference of a year old plant was 1.08 cm. Therefore, three age groups of *H. integrifolia* were identified in a population. One year old plants with 1 cm circumference, saplings with 1 to 31.5 cm and trees with 31.5 cm girth (Saxena *et al.* 1978).

The samara is a one seeded, dry, indehiscent, winged fruit. The production per plant was estimated by laying down 20 quadrats of 10 m x 10 m each, for each study site when the fruit was almost mature in the last week of

March, 1998. The number of samara per fertile plant were estimated as follows:

Total samara production =

No. of primary branches per fertile plant x

No. of secondary branches per primary branch x

No. of tertiary branches per secondary branch x

No. of samara per tertiary branch.

Further observations were taken from three study sites — Dhobighatta hills, Sagar hills and R.R. College campus. The number of samara present on the soil surface was estimated by laying down 20 quadrats of 1 m x 1 m after its dispersal was almost over in the last week of April, 1998. Monsoon set in the last week of June in 1998, and after 10 days of sufficient rainfall, the number of established seedlings were estimated by laying down 20 quadrats of 1 m x 1 m in all the three study sites.

Survival of established seedling populations of *H. integrifolia* was studied at R.R. College and Sagar hills. Seedling establishment was almost negligible at Dhobighatta hills. Since seedling density was very low at R.R. College, four permanent quadrats of 1 m x 1 m were laid down where the density of *H. integrifolia* seedlings was maximum, whereas five permanent quadrats of 1 m x 1 m were laid down at random at Sagar hills where seedling recruitment was uniform and good throughout.

The physico-chemical parameters of all the four study sites were analysed by taking five soil samples from each site at random, from an area of 10 cm x 10 cm x 10 cm. Soil samples from each study site were mixed and analysed at the Soil Testing Laboratory, Agriculture Department, Govt. of Rajasthan, Alwar. To evaluate the effect

TABLE 3
SAMARA (FRUIT) PRODUCTION BY *HOLOPTELEA INTEGRIFOLIA* ($\pm$ S.E)

Site	Plants /100 sq. m	Fertile Plants /100 sq. m	No. of samara per plant ($\times 10^3$)	No. of samara /100 sq. m ($\times 10^3$)
Dhobighatta hills	3.1 $\pm$ 0.4	1.5 $\pm$ 0.47	3	4
Sagar hills	17.3 $\pm$ 1.3	0.6 $\pm$ 0.15	9	5
R.R. College campus	11.4 $\pm$ 1.3	0.7 $\pm$ 0.2	19	13
Garvaji	1.4 $\pm$ 0.1	1.2 $\pm$ 0.18	273	328

of soil moisture content on seedling survival, five soil samples were taken from 0-10 cm depth from the vicinity of the permanent quadrats whenever required. The soil moisture content was estimated by the method of Mishra (1968).

RESULTS

Distribution: *H. integrifolia* grows in most parts of Alwar district (Fig. 1) It is particularly abundant in the hilly tracts. Since it is not a climax species, it grows in deforested areas, treefall gaps and along water channels in the Sariska Tiger Reserve. The highest density of *H. integrifolia* was observed at Sagar hills, whereas the lowest was at Garvaji (Table 1).

Samara production and dispersal: 85%, 48%, 3.5% and 6% plants of *H. integrifolia* were fertile at Garvaji, Dhobighatta hills, Sagar hills and R.R. College respectively (Table 3). Maximum samara production per plant was at Garvaji, whereas it was very low at Sagar hills and Dhobighatta hills (Table 3). Number of samara reaching the soil surface after dispersal was highest at Sagar hills and lowest at Dhobighatta hills (Table 4).

Establishment and survival of seedlings: *H. integrifolia* seedlings established well at Sagar

hills, but almost negligibly at Dhobighatta hills (Table 4). Only 5% and 46% seedlings survived at R.R. College and Sagar hills respectively beyond the first week of establishment. Seedling population experienced less mortality from August to December 1998. An increase, however, was observed in January 1999, at both the study sites. All the seedlings at R.R. College died by January 1999, while 20 seedlings /100 sq. m survived up to June 1999 at Sagar hills (Fig. 2).

Age structure: Age-structure analysis of *H. integrifolia* populations showed that the one year age group was present only at Sagar hills (Fig. 3). The saplings were present in all the study sites except Garvaji where both seedlings and saplings were absent. Among the other three study sites, R.R. College had the highest, i.e. 4.4 saplings /100 sq. m, followed by Sagar hills where 2.4 saplings /100 sq. m were recorded. The maximum density of the tree age group was 7 trees /100 sq. m at R. R. College.

DISCUSSION

The Alwar district survey suggests that *H. integrifolia* grows luxuriantly around Alwar and Rajgarh towns, and deforested areas protected by the forest department. It is also found

TABLE 4
REGENERATION POTENTIAL OF *HOLOPTELEA INTEGRIFOLIA* /100 SQ. M

Study Site	Samara reaching soil surface	No. of seedlings established	No. of seedlings survived after one year
Dhobighatta hills	360	Negligible	Nil
Sagar hills	2,810	1,070	20
R.R. College campus	2,108	386	Nil

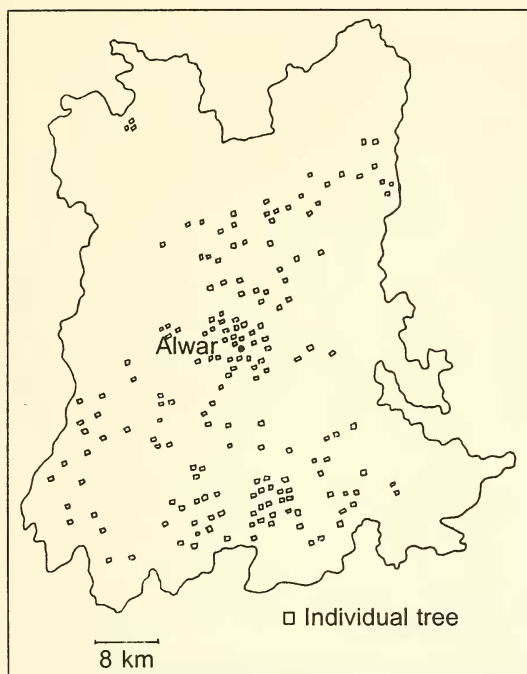


Fig. 1: Map of Alwar district showing the distribution of *H. integrifolia*

growing along roadsides, railway lines and around human habitations in hilly regions. It is almost absent in the plains of Behror, Tijara, Kishangarh and a part of Luxmangarh subdivisions. (Fig. 1).

The high percentage of fertile plants in Garvaji and Dhobighatta hills and low percentage at Sagar hills and R.R.College, suggests that grazing by goats and cattle destroy the seedlings and saplings in these formerly disturbed areas. The samara production per plant was maximum at Garvaji site because all the fertile plants were full grown trees, whereas it was less at R.R.College, a large number of fertile plants being younger. In hilly areas, samara production was low due to the stunted growth of the trees.

Of the total samara production per unit area, only a small fraction reached the soil surface at Dhobighatta hills and R.R.College, may be

due to the open habitat where seeds are widely dispersed by wind. However, more than 50% of samara produced per unit area reached the soil surface at Sagar hills because of the small size of the site, northeast direction of the slope and hills surrounding the western and northern sides.

Percentage of seedlings established per unit area of the soil surface was very low, suggesting that a large number of seeds were eaten by goats, rodents and red ants. Some might have been washed away by the rains. This was confirmed experimentally in August 1998, with 9 samples, each with 50 samara, placed at different locations at R.R. College. After 4 days it was observed that 24% samara were damaged, their seeds removed by rodents or damaged by small red ants. After 10 days, the rest of the seeds were lost. They might have been washed away in the rains which continued for three days. Loss of seeds due to heavy rain has been reported for other tree species (Dagar *et. al.* 1978). The poor establishment of seedlings at R.R. College may also be due to the destruction of all the seeds of a tree by some insect. Whitefly epidemic in *H. integrifolia* has been reported by Mishra and Mishra (1995). However, at Sagar hills about 40% of seeds reaching the soil surface were established as seedlings (Table 4). This may be due to the protection of the site against grazing, absence of rodents and other seed predators, as large numbers of healthy seeds were present at the commencement of rains. The loss of samara due to monsoon run off may be prevented by small stones, pebbles and shrubs.

Seedling survival was very low in all the three study sites, as only a few seedlings survived over a year at Sagar hills. The mortality rate was highest in the dry periods of the rainy season when the soil moisture was very low (Table 5) and the soil surface temperature was above 41 °C at R.R. College. It was observed that most of the seedlings died due to permanent wilting. However, seedling mortality rate was less at

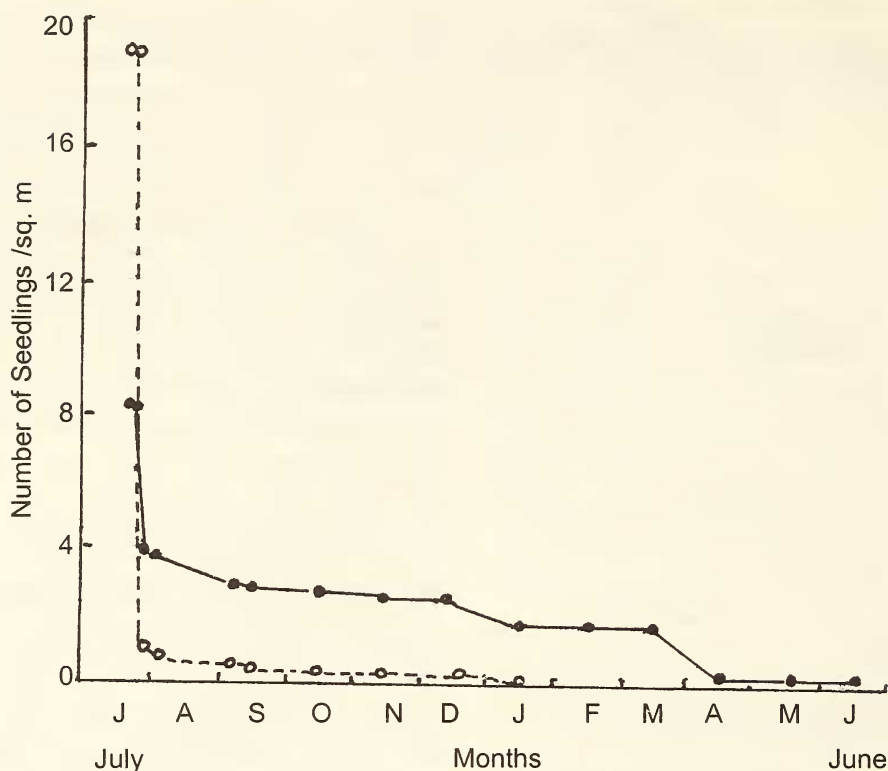


Fig. 2: Survival of seedling population of *H. integrifolia* at R.R. College campus (O-----O) and Sagar hills (●—●)

Sagar hills, perhaps due to the protective shrub cover like *Wrightia tinctoria* and *Adhatoda vasica*. Second to the monsoon, the seedlings experienced greatest mortality in January, when the soil moisture was low and temperature dropped below 4 °C. This is in conformity with the high seedling mortality due to low soil moisture and low temperature in other tree species (Tripathi

and Khan 1992, Rao *et. al.* 1997).

The age-structure of *H. integrifolia* population at different sites suggests that its natural regeneration is taking place only at Sagar hills and R.R. College campus because the former is fully and the latter partially protected against biotic disturbance. Seedlings and saplings were absent at the overgrazed Garvaji and Dhobighatta hills, indicating the role of biotic disturbance in regeneration of *H. integrifolia*. This was confirmed when it was noticed that *H. integrifolia* is not preferred by grazing animals, but in the absence of green vegetation, goats and cattle grazed on it. It may be concluded that some seedlings of *H. integrifolia* may be damaged by the trampling of cattle. This tree species grows at places beyond

TABLE 5
SOIL MOISTURE CONTENT (%) OF
R.R. COLLEGE CAMPUS AND SAGAR HILLS

Observation Periods	Sagar hills	R.R.College Campus
24 hours after rainfall on		
17th July, 1998	13.5	11.6
7 days after rainfall on		
24th July, 1998	2.6	3.8
In dry winter season on		
21st February, 1999	5.90	4.2

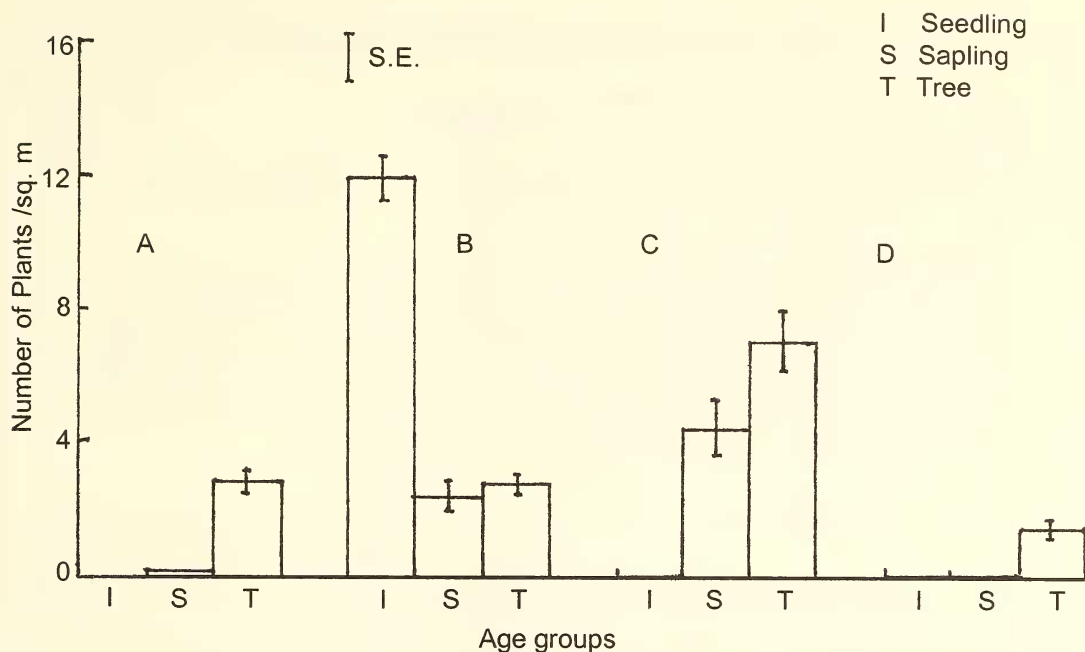


Fig. 3: Population age-structure of *H. integrifolia* at (A) Dhobighatta hills (B) Sagar hills (C) R.R. College campus and (D) Garvaji.

the reach of man or grazing animals, such as crevices of rocks, on steep slopes and among thorny bushes. It was concluded that the natural regeneration of *H. integrifolia* is adversely affected by both abiotic and biotic factors, and takes place only in areas which are partially or fully protected against grazing.

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